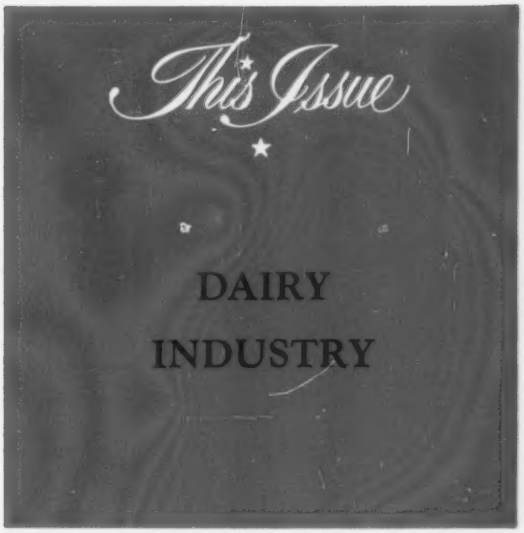
Volume 46 JUNE, 1960 *Number 6*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants



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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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Vol. XLVI June, 1960 No. 6

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DAIRY INDUSTRY

More milk is produced in the United States than any other single food item, in fact fifteen billion gallons are produced annually on almost three million farms which amounts to approximately 250 quarts for every person in the country. The dairy industry processes and distributes hundreds of types of dairy products such as: raw, homogenized and pasteurized milk; cream; butter; cheddar, cottage and other cheeses; ice cream, frozen desserts and novelties; evaporated and condensed milks; dried whole and skimmed milk solids; buttermilk; sour cream; and many by-products.[1]

In order to produce such a variety of dairy products for our consumption, the dairy industry has in the last twenty years utilized many technological advancements in methods and in the types of equipment necessary to process fluid milk and the many by-products. Milk processing equipment includes a variety of pumps, electric motors, conveyors and special machines wherein use of the right lubricant is very important in obtaining optimum performance. The purpose of this article is to describe some of the methods and equipment used in the dairy industry, and to discuss some of the lubrication aspects involved.

The total pounds of milk products produced each year has generally paralleled our population growth. Figure 1 illustrates that as a consequence of selective breeding and scientific care, the milk production per cow has increased tremendously in recent years while the actual number of dairy cows in the United States has gradually decreased. To accomplish these changes during such a short period, dairy farming has become a highly specialized business.

[1] "This Is The Dairy Industry" published by Milk Industry Foundation.

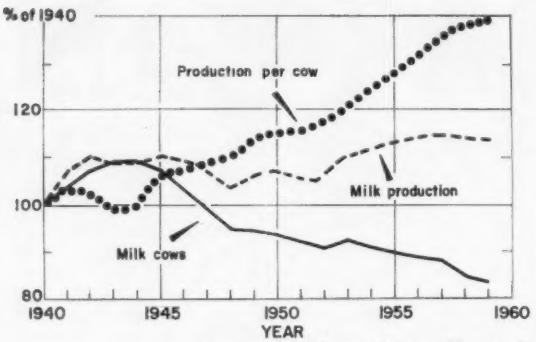
ON THE FARM

The story of the dairy industry starts at the dairy farm for it is here that milk, the basic ingredient, is obtained. The modern dairy farm has come a long way since the days when all cows were individually milked by hand. Modern technological and mechanization advances have provided the dairy farmer means to feed and care for his cows, to obtain milk faster, more efficiently, and to provide a hygienic and more uniform product.

Cattle Care

The dairy farmer can select from a variety of equipment that has been designed to increase production and make his work easier and more efficient. A modern dairy barn might include such items as an automatic barn cleaner, controlled ventilation, automatic feeders and a number of power hoists to handle heavy or bulky material.

For example silage in the silo can be removed automatically with an unloader like that shown in Figure 2. A motor-driven high speed chain with "flights" (cutter pins) cuts through even frozen silage, and moves it to a restricted opening in the discharge housing where silage "slugs" (chunks) are chopped up before being blown through the discharge and out the silo door. Lubrication of electric motors and gear reducers similar to those



Courtesy of Dairymen's League News and U. S. Department of Agriculture.

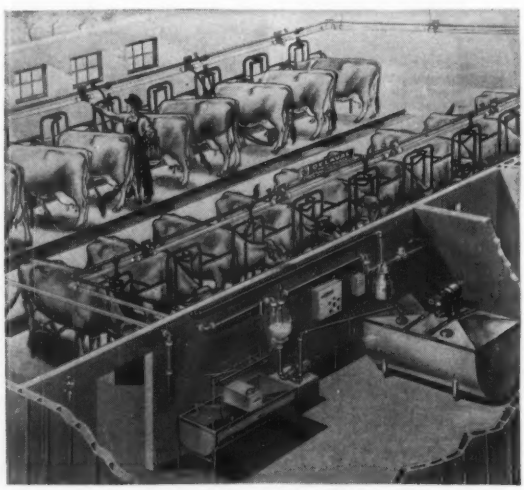
Figure 1 — Dairy trends during the past twenty years.

used in this equipment will be discussed later.

Depending upon the size of his herd and his particular preference, the dairy farmer can also select from a variety of methods to milk his cows. Automatic mechanical milking systems are available in single or multiple units: for the large herd owner, the multiple units offer the most advantages.

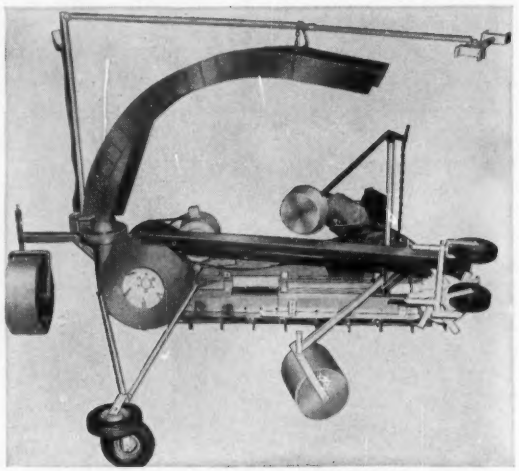
A mechanical milking installation is shown in Figure 3 with schematic diagram of it in Figure 4. There are actually three parts in this system: (1) the suction or vacuum system for obtaining the milk from the cows and delivering it to a milk receiving jar, (2) the milk system for pumping milk from the receiving jar to a bulk storage tank and (3) a cleaning and sanitizing system.

Vacuum can be supplied either from a permanently located unit such as shown in Figure 5 or a similar but portable unit. The particular unit illustrated is of the piston type with a splash lubrication system. Straight mineral oils can be used in this pump or similar types, but a rust and oxidation inhibited turbine oil is preferred where moisture



Courtesy of DeLaval Separator Company

Figure 3 — Automatic mechanical milking system.



Courtesy of Louden Machinery Co.

Figure 2 — "Level Cut" silo unloader.

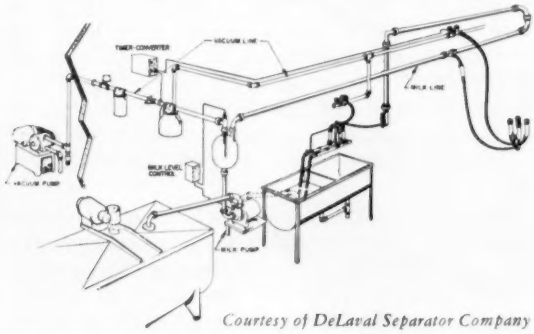
is a problem. The viscosity ranges from 300 to 1000 Saybolt Seconds Universal (SSU) at 100°F. depending upon the exact type pump being used.

Another vacuum system in common use, utilizes a rotary vane-type pump, having four vanes which create four vacuum pulses each revolution. A premium grade rust and oxidation inhibited turbine oil having a viscosity of 300-325 SSU at 100°F. is used for lubricating this pump.

In the milk system, milk is pumped from the receiving jar into a bulk storage tank. An electric motor driven centrifugal or diaphragm pump can be used for this purpose.

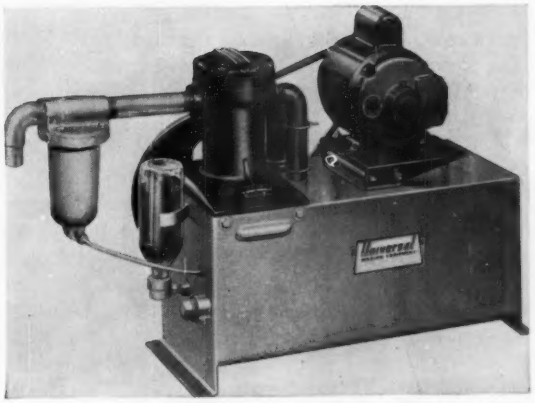
All pipes and component parts of these vacuum and milk systems can be cleaned and sanitized by recirculation of a detergent solution at high velocity using both the vacuum and positive-pressure milk pumps for this purpose.

Figure 6 illustrates a vacuum bulk milk cooler for collection and temporary storage of milk on the farm which is either vacuum-jacketed like a large thermos bottle or is heavily insulated. Incoming milk can be quickly cooled and maintained at a



Courtesy of DeLaval Separator Company

Figure 4 — Schematic diagram of automatic milking system shown in Figure 3.



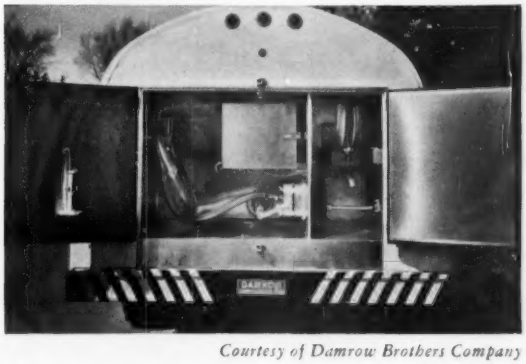
Courtesy of Universal Milking Machine Div., National Cooperatives, Inc.

Figure 5 — Single-cylinder vacuum pump for automatic milking system.

constant temperature of about 40°F. Provisions are available in the tank for cleaning and sanitizing it with a high velocity spray system.

Transport to Milk Plant

Methods of getting milk from the farm to the milk plant have also changed. Traditionally, the farmer gathered the milk in heavy tinned forty quart cans (containing about 86 pounds) and had them delivered by open truck to a milk handling plant in a near-by city. This practice is still followed by many of the smaller dairy farms. As previously noted, however, bulk milk tanks are now favored for holding milk on the farms and special milk tank trucks like that shown in Figures 7 and 8 are employed to transport it quickly to the milk processing plant. Such trucks may be equipped with their own pumping equipment as illustrated in Figure 7, or may depend on stationary pumps at the processing plant to unload and transfer the milk into the milk plant's processing system. The truck (or trailer) tanks are so well insulated that they maintain the low milk temperature as received



Courtesy of Damrow Brothers Company

Figure 7 — Back view of 1800 gallon farm bulk milk pickup truck with doors open to show features. Note electric motor driven pump with heavy duty electric cord reel.

Courtesy of Universal Milking Machine Div., National Cooperatives, Inc.

Figure 6 — Vacuum bulk milk cooler for receiving and temporarily holding milk on the dairy farm.

from the farm. The interiors of these tanks are usually lined with stainless steel and all auxiliary equipment is similarly designed and constructed to insure that the milk is transported and transferred in a most sanitary manner. As an example attention is invited to the transparent plastic discharge tube and stainless steel pump shown in Figure 7.

IN THE MILK PLANT

There are over 35 thousand plants[2] throughout the United States which process milk and one half of the total milk production is used for drinking purposes. The following paragraphs describe types of equipment that may be used to process and deliver this popular beverage to the consumer.

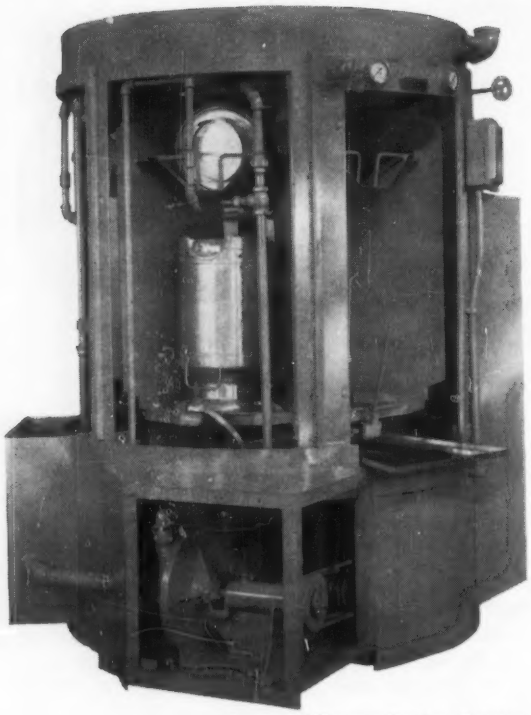
Milk Can Receipt

When milk is received in cans, they are removed from the truck manually and placed on a conveyor chain which moves them to the weighing room. Since one truck may contain cans picked up from several different farms, the cans from each farm are premarked with the farm's identification number and kept separate until they are emptied into a weighing tank and samples are taken for butter fat and other quality analyses. The empty cans and

[2] "This Is The Dairy Industry" published by Milk Industry Foundation.

Courtesy of Damrow Brothers Company

Figure 8 — 4500 gallon two compartment bulk milk pickup tank on tandem axle semi-trailer.



Courtesy of Damrow Brothers Company

Figure 9 — View of rotary can washer showing motor drive assembly and centrifugal pump.

their tops are then fed into an automatic can washer like that shown in Figure 9 where they receive a pre-rinse, a solution wash, a hot rinse, sterilizing steam and are then dried at the rate of four per minute. The driving motor and two centrifugal pumps of this unit appear beneath the rotating compartmented washing rack.

After washing, the cans are returned by conveyor to the truck loading platform and the process can be so timed that as soon as the driver completes unloading of full cans, he can move his truck to another platform and begin reloading the same (but cleaned) cans for return to the dairy farms.

Bulk Milk Receipt

Milk arriving at the dairy plant in milk tank trucks is pumped through glass or stainless steel lines to a receiving tank where it is weighed and samples are taken to check for butterfat content and general condition. The milk is then pumped into large insulated holding tanks like the three shown in Figure 10 where it is maintained at a temperature of about 40°F while awaiting processing.

Equipment is available at the dairy plant so that after the milk has been pumped from the milk tank truck, the tank can be thoroughly cleaned. Spray nozzles are inserted through an opening in the top of the tank and a cleaning solution is sprayed under pressure on the inside area of the tank. Milk bulk tank trucks are usually cleaned after each individual delivery and completely sterilized at the end of each day.

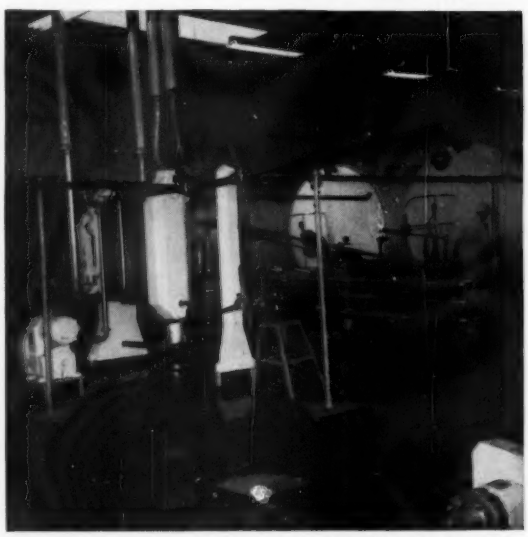
Clarification and Pasteurization

Milk from the holding tank is pumped through the clarifier where it is centrifuged at speeds of approximately 6,000 rpm to remove any solid particles that might clog homogenizer nozzles. Vitamin D may be added at this time to "fortify" the natural content. The milk is then pumped through a pre-heater to bring the temperature up slowly, then through the pasteurizer where it is held carefully at a temperature between 160 and 170°F for precisely 15 seconds: any longer time or higher temperature may damage its flavor, while lower temperatures or shorter times may not inhibit souring organisms properly.

Separator

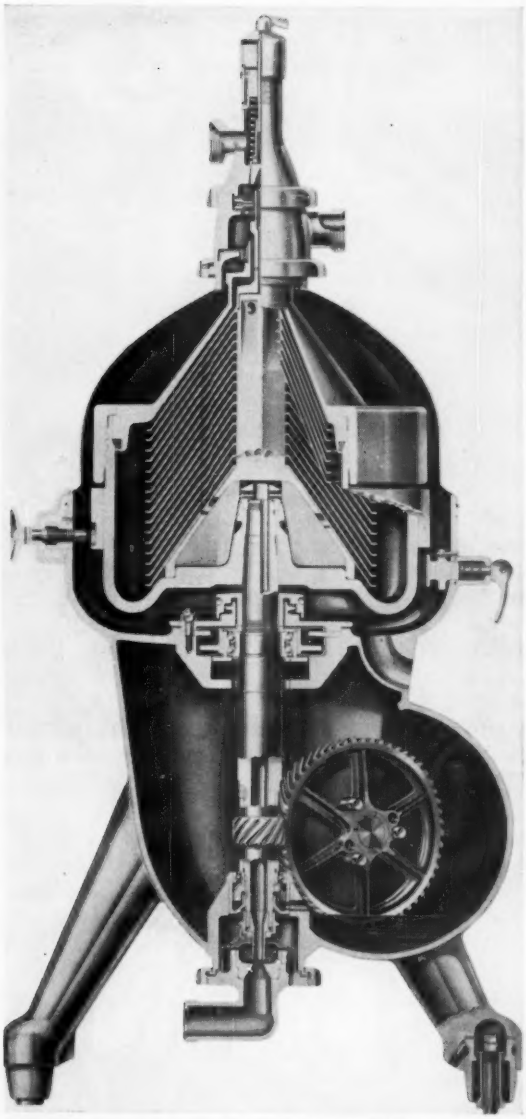
When milk is to be processed for use other than for homogenized milk, it is usually pumped through a separator like that shown in Figure 11 which can be regulated to remove part or all of its cream or butter-fat content. The remaining non-fat "skimmed" by-product milk is used in a variety of other products. In order to develop the required amount of centrifugal force, the separator bowl is rotated at approximately 6,000 revolutions per minute.

The working elements of the separator are built to precision dimensions and are mounted on ball



Courtesy of Crowley's Milk Company, Inc.

Figure 10 — View inside dairy plant showing three bulk holding tanks for milk in background and pasteurizing unit and preheating assembly in foreground.



Courtesy of DeLaval Separator Company

Figure 11 — Cross sectional view of commercial separator showing details of working elements.

bearings. The housing is totally enclosed and a splash proof motor is used.

Homogenization

Milk is homogenized to prevent the natural separation of its cream (butter fat) content, i.e. to assure that it remains as a single homogenous fluid. Milk entering an homogenizer like that shown in Figure 12 contains butter fat globules ranging from 2 to 20 microns in size, all unequally dispersed throughout the product. As the milk passes through the homogenizing valve assembly, it undergoes an extreme, instantaneous change in velocity (in the order of a tenfold increase at approximately 2000 psi operating pressure). As each fat globule enters this zone of velocity increase, small particles of from one to two microns in size are sheared off and evenly distributed throughout the product. These much-smaller globules are unable to coalesce again into larger ones, thus separation can not occur. Operating pressures vary with the particular type of equipment being used.

An homogenizer can present a real challenge to the lubricant being used. The driveshaft bearings may be of the roller type, the plain crankshaft bearings of bronze, straps on the eccentrics are probably babbitt lined, crossheads are of cast iron and the gears of steel. The oil, therefore, must lubricate a variety of materials and heavily-loaded mechanisms.

A premium grade turbine oil containing a defoaming agent, oxidation and corrosion inhibitors and having a viscosity of 1000 to 1500 SSU at 100°F is frequently recommended as a crankcase lubricant for such equipment.

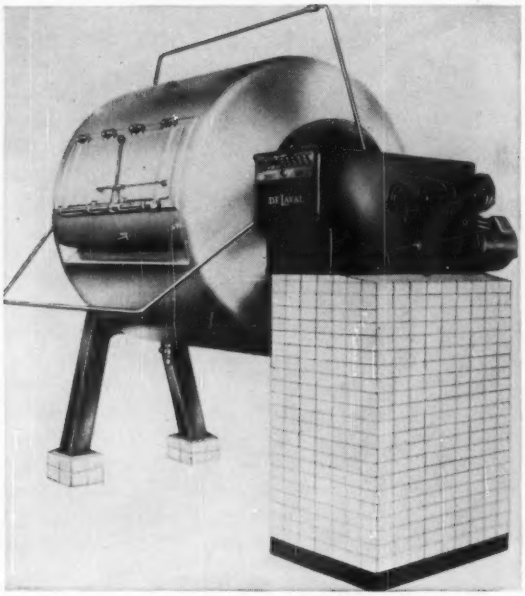
The clarified, pasteurized, homogenized milk is then pumped into "balance" tanks located above the floor level where it can be subsequently fed by gravity to the various milk filling machines which will be described under Milk Packaging.

MILK BY-PRODUCTS

As mentioned earlier, the dairy industry manufactures literally hundreds of types of dairy products. While it is impossible to describe how all of these are made, the following information on some of the more familiar items will be of interest.

Courtesy of Manton-Gaulin Manufacturing Co., Inc.

Figure 12 — Front view of two-stage homogenizer.



Courtesy of DeLaval Separator Company

Figure 13 — Butter churn.

Butter

The fat solids from about one-fourth of the milk produced in this country are made into butter. In the early days, farmers churned their own butter for the market, feeding skim milk to the livestock. Butter is now produced commercially by churning pasteurized (but not homogenized) sweet or sour cream which coalesces the tiny butter-fat globules into large masses in equipment like that shown in Figure 13. The residual buttermilk is drained off, the butter washed to remove the remaining buttermilk, frequently salted and finally "worked" until it is of the proper consistency and moisture content.

Cheese

Some historians say that men made cheese even before they made butter, and that during the Dark Ages of Europe the invading Gothic horsemen carried cheese in their saddle bags for the long trips. Commercial production of cheese in the United States started with cheddar (American) cheese in upstate New York and moved slowly westward following the center of dairy production[3].

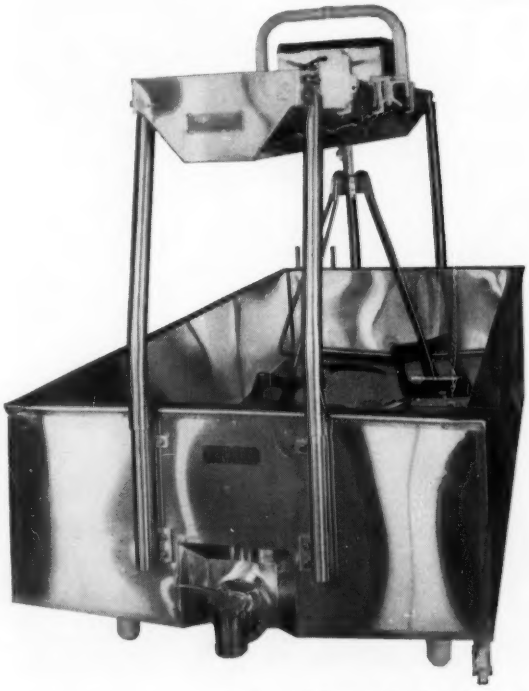
Although cheeses are sold under several hundred different names, according to the method of manufacture, the manufacturer's brand name or the locality, there are only about 18 distinct types[4]. Cheddar cheese, the most widely consumed in this country, is generally made from pasteurized cow's milk, either whole or skimmed. Cheese is the "curd" or collected solids of milk, separated from the residual liquid "whey" by coagulating the milk, stirring, heating and draining off the whey. The curd is then "cured" (ripened, aged) into cheese by holding for a specified time under controlled temperature and humidity conditions. During this process, the characteristic flavor and texture of a given cheese are developed by the action of its unique combination of bacteria or molds. The curd is later cut into pieces, ground, melted, pasteurized and stirred into a homogeneous mass which is salted, packed into hoops, pressed to consolidate it, and frequently aged still further.

Figure 14 illustrates a cheese vat equipped with an agitator-forker mounted above the vat and so arranged that it can automatically travel from one end to the other at any of ten different speeds.

Ice Cream Mix

About six per cent of the nation's milk production is used for making ice cream. In general, most milk processing plants do not make ice cream itself in its final form but rather an ice cream "mix" which is then sold to the specialized ice cream manufacturer. The ice cream mix is pasteurized, homogenized, cooled and aged by holding a few hours at 32 to 40°F.

An average ice cream mix contains 12 per cent butter fat (by weight) 11 per cent milk-solids (not

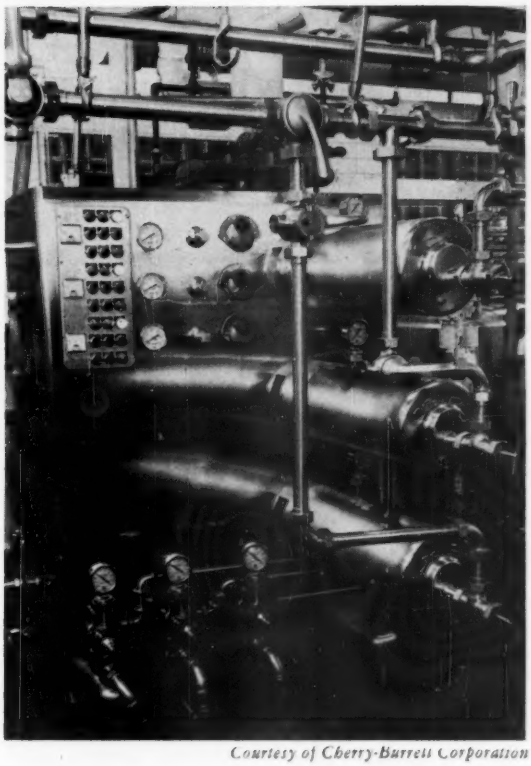


Courtesy of Damrow Brothers Company

Figure 14 — Stainless steel cheese vat with agitator-forker assembly.

[3]Milkman's Economics — The Story of Milk Processing and Distribution. Milk Industry Foundation.

[4]Cheese Varieties and Descriptions. Sanders, G. P., U. S. Dept. Agriculture Handbook No. 54, 1953.

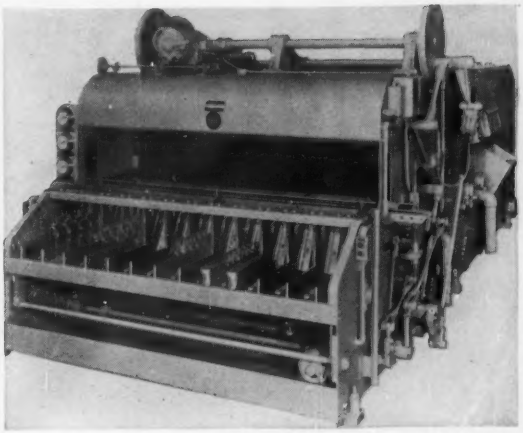


Courtesy of Cherry-Burrell Corporation

Figure 15 — Automatic machine for making ice cream having three separate freezing systems.

fat), and 15 per cent sugar. With the addition of a stabilizer and other optional ingredients, it contains a total of about 38 per cent by weight of solids. Optional ingredients include cane or beet sugar, corn syrup, honey, and egg-yolk solids. The ice cream manufacturer adds flavoring material, nuts, fruits, etc.

An ice cream freezer containing three separate and independent cylindrical freezing systems is shown in Figure 15. Each cylinder has its own injection refrigeration control system comprising of a separate accumulator with an injector that picks up liquid refrigerant, delivers it through a distributing area beneath the freezing tube, and sprays it over the heat transfer surfaces to obtain extremely rapid chilling and freezing. Separate V-belt drive motors are used for each unit.



Courtesy of Cherry-Burrell Corporation

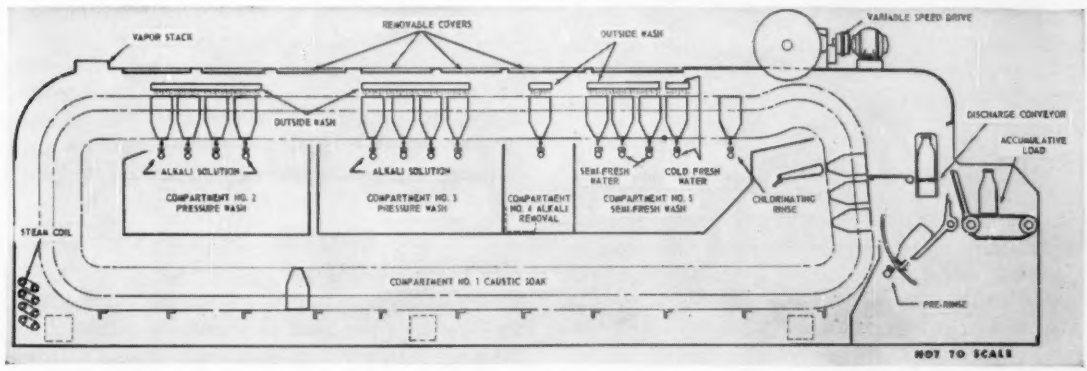
Figure 16 — Automatic bottle washer capable of washing up to 140 bottles per minute.

MILK PACKAGING

Packaging equipment in the modern dairy plant will include facilities for filling the familiar glass milk bottle, paper containers, 20 and 40 quart bulk delivery cans, and occasionally the tank truck.

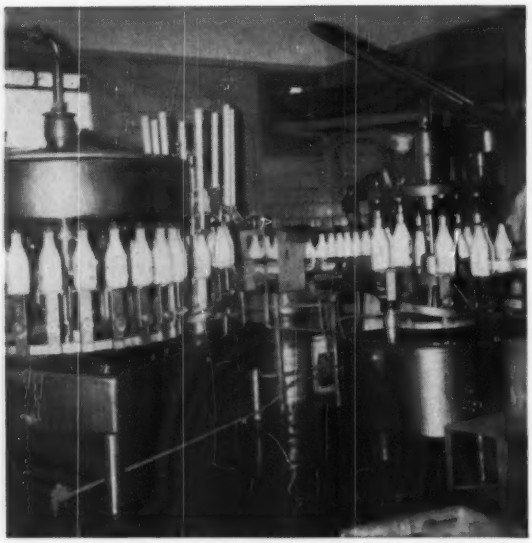
Glass Bottles

Cases of empty milk bottles returned to the milk plant by the milk truck route drivers are unloaded onto a conveyor which transports them to a bottle washing machine like that illustrated in Figure 16 where they are removed from the cases and placed in the washer. The number of bottles washed per minute may be as high as 140 but is regulated to



Courtesy of Cherry-Burrell Corporation

Figure 17 — Schematic view of automatic bottle washer shown in Figure 16.



Courtesy of Crowley's Milk Company, Inc.

Figure 18 — One-quart glass milk bottles being automatically filled and capped.

Courtesy of Crowley's Milk Company, Inc.

Figure 19 — Paper cartons being filled in automatic machine.

correspond to the capacity of the milk filling machine. This is necessary since the output of the washer is fed directly to the bottle filler to avoid any possible contamination. Bottles are placed in the receiving rack and as schematically diagrammed in Figure 17 they are first given a pre-rinse to remove loose dirt and to temper the bottles for the soaking operation. They then move fully submerged through the cleaning compound soak compartment for 5—8 minutes at a temperature of about 150°F. This treatment chemically removes greasy or fatty materials, milk sugars and other solubles.

The bottles then continue through the washer receiving additional cleaning treatments and finally a cold fresh water rinse inside and outside.

The clean, empty bottles are then automatically filled with milk in a bottling machine like that shown in the left of Figure 18, then capped in the machine on the right, and in many instances supplied with a protective cover over the top of the bottle. The filled bottles are then placed in cases and moved by conveyor to a cold storage room where they are held at a temperature of 40°F pending delivery.

Paper Cartons

There has been an increasing use of paper cartons for packaging milk. Cartons can be received by the dairy plant either ready for filling (such as the small one-half pint size) or folded flat. The folded cartons are fed into filling machines like those shown in Figures 19 and 20, automatically expanded into box form, bottoms sealed, coated (except where plastic cartons are used), filled with milk, resealed and rinsed externally. Manually-filled cases are conveyed to the cold room.

Packaging equipment utilizes a variety of motors, pumps, gear reducers and specially designed mechanisms from one end of the machine to the other, most of which requires periodic lubrication. Grease fittings can generally be lubricated with a good multi-purpose grease. Correct selection of the lubricant for the gearing applications will depend upon the loads, speeds and types of gears involved. Recommendations for the optimum lubricant can be obtained from the equipment manufacturer or lubricant supplier.

Can Delivery

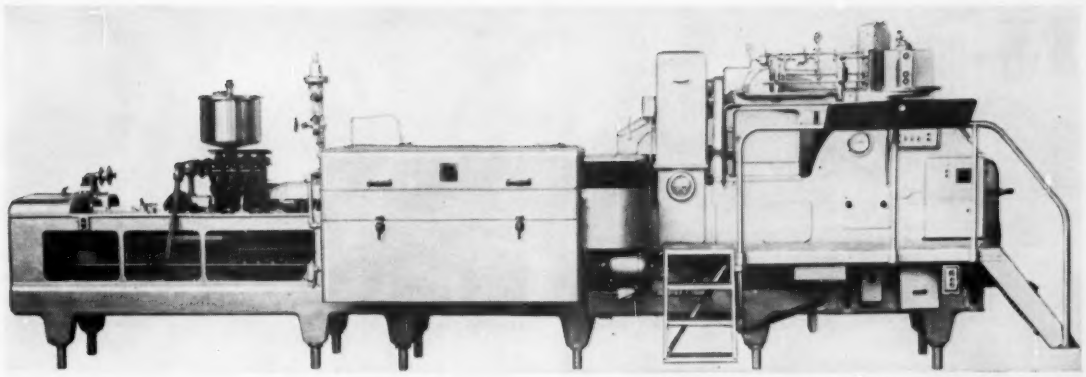
Many customers using large quantities of milk also find it advantageous to have their milk delivered in 20 or 40 quart bulk delivery cans. Prior to being filled with milk, the cans are completely washed and cleaned in an automatic can washer such as shown in Figure 9.

Truck Delivery

An important adjunct to bringing a uniform product to the customer's doorstep is the use of a well designed dairy delivery truck. The modern dairy truck has an insulated and refrigerated compartment for maintaining the milk and dairy products at a constant temperature of 40°F.

EQUIPMENT HYGIENE

In the processing of milk in the dairy plant, a considerable amount of piping and of course a number of pumps are used to transfer the milk from one process to another. Stainless steel and in some cases glass is used for the piping material and other equipment is very largely made of stainless steel or



Courtesy of Pure-Pak Division Ex-Cell-O Corporation

Figure 20 — Automatic machine for filling paper milk containers.

monel. To assure a satisfactory product, it is necessary to clean these pipes daily. Some systems are arranged so that the cleaning solutions can be pumped through the pipes without disassembling them. Quick-disconnect couplings are used for joining pipe sections which must be removed for cleaning.

EQUIPMENT LUBRICATION

The lubrication of some individual special equipment has already been described. This section will touch upon the lubrication of such widely used equipment in a milk plant as motors, pumps, conveyors, gear reduction units and refrigeration compressors. In summation it will offer a Simplified Lubrication Plan for the Dairy Industry.

Electric Motors

To provide power for the many types of equipment used in the dairy industry, a multitude of electric motors of various designs and sizes are used. In general these motors are grease lubricated. Greases furnish better seals against the entry of contaminants such as dust, dirt, moisture or animal acids, thereby serving to protect the bearing elements more effectively. In some cases specialty greases are required but in general a good multi-purpose grease can be used. Multi-purpose greases are also successfully used to lubricate the many other points of friction on the various pieces of equipment. Requirements may vary for specific applications but the following grease characteristics must generally be considered:

1. Resistance to oxidation
2. Rust protection
3. Anti-wear and extreme pressure properties
4. Grease pumpability
5. Non-corrosiveness to the metals being lubricated
6. Satisfactory torque requirements at the temperature being used
7. Resistance to excessive oil separation
8. Freedom from components which might tend to cause the lubricating film to become sticky or the grease itself to gum
9. Good storage stability

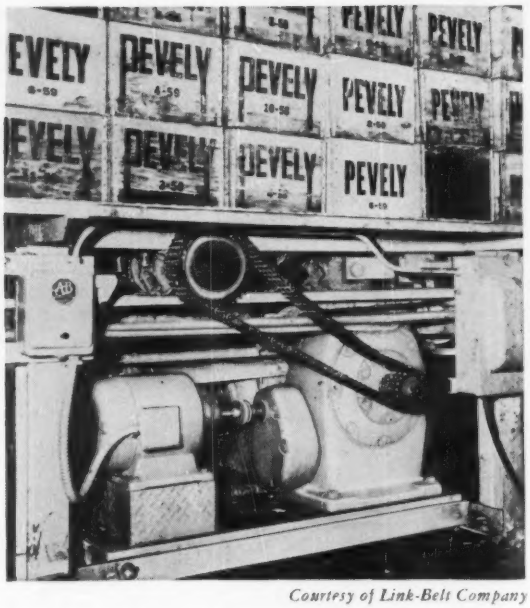
Oil-lubricated electric motor bearings are best served with a rust and oxidation inhibited premium grade turbine oil having a viscosity of about 300 SSU at 100°F (SAE 20-20W).

Pumps

During the various stages of processing milk from the time it arrives at the dairy plant until it reaches its final destination, a number of pressure sanitary pumps are required to move the product from one

Courtesy of The Creamery Package Mfg. Co.

Figure 21 — Five-lobe stainless steel rotary pump for handling liquids and semi-solids.



Courtesy of Link-Belt Company

Figure 22 — Drive unit for conveyor system showing motor, flexible coupling, helical and worm gear speed reducer, and roller chain connected to conveyor drive shaft.

Courtesy of Link-Belt Company

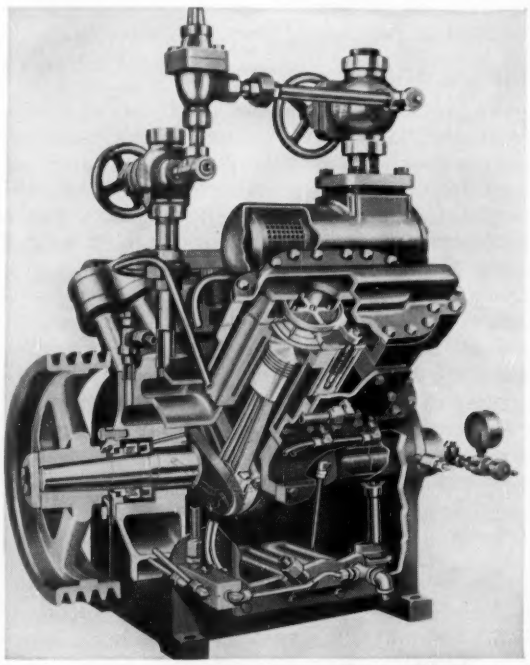
Figure 23 — View showing conveyor systems bringing empty metal cases to paper carton filling machines.

processing step to another. Centrifugal or rotary type pumps are used for this purpose. A five-lobe stainless steel rotary pump capable of handling liquid and semi-solids is illustrated in Figure 21. A product entering the pump case is alternately drawn into chambers formed between the lobes of each rotor and the inner circumference of the case and discharged on the opposite side. In the particular type pump shown in Figure 21, the rotors have resilient coverings which form a continuous flexible seal. These coverings are resistant to mild acids, most animal and vegetable fats and oils.

The internal pumping mechanisms of sanitary pumps require no lubrication other than that received from the product being pumped. Where gear sets are used to provide power to the rotating elements, they are enclosed in a tightly sealed gear case and usually run in an oil bath. The driving gears can be lubricated with a rust and oxidation inhibited turbine oil having a viscosity of approximately 300 SSU at 100°F.

Chain Drives and Conveyor Systems

A variety of chain drives for power transmission and conveyor chain systems for transporting packaged milk and milk by-products from one location to another are used in the modern dairy plant. Chain drives like that illustrated in Figure 22 consist of a parallel series of links of such contour so as to enable them to engage with teeth in the sprocket wheels and insure positive power transmission. The links are fastened to each other and to the adjoining links by pins and bushings and allow extreme flexibility of the entire chain with very little noise or wear providing proper lubrication has been carried out. Depending upon the speeds, location and particular range of operating conditions, a variety of lu-



Courtesy of Creamery Package Mfg. Company

Figure 24 — Sectionalized view of multi-cylinder ammonia compressor.

TABLE I

Simplified Lubrication Plan for Dairy Industry Equipment

Mechanism	Lubricant	Approximate Oil Viscosity SUS at 100°F. or NLGI Grease Grade
Air compressors		
reciprocating	R	300
rotary	R	1000
Chain drives		
exposed	R	2000
inclosed	R	300
Cream separators and clarifiers	R	300 or 400
Hydraulic systems	R	150
Homogenizers	R	1000
Speed reduction units	R	1000 or 2000
Vacuum pumps	R	300
Conveyor bearings		
oil lubricated	R	300
grease lubricated	G	NLGI #2
Electric motor bearings		
oil lubricated	R	300
grease lubricated	G	NLGI #2
Pressure pump bearings and drive gears		
oil lubricated	R	300
grease lubricated	G	NLGI #2
Grease fittings	G	NLGI #2
Ammonia refrigeration compressors	A	150, 200 or 300

Lubricant	Description
R	Premium grade rust and oxidation inhibited turbine and hydraulic oil.
G	Premium ball, roller and plain bearing grease; oxidation resistant; wide temperature range; sodium-calcium or lithium soap; oil viscosity 200-500 SUS at 100°F.
A	Highly refined, dewaxed, low cloud point refrigeration oil: viscosity grade as recommended by compressor manufacturer.

brication methods may be used. Manual lubrication using a brush or spout type can may be used with low horsepower drives and chain speeds under 600 feet per minute. Under these conditions drip-cup lubrication may also be used. Other methods include splash lubrication and oil disc lubrication (an oil disc mounted on the lower sprocket dips into an oil bath and automatically brings lubricants to the chain). Forced feed lubrication where a continuous spray of oil impinges against the chain is also used. When chains are encased, an oil having a viscosity of about 500 SSU at 100°F will be suitable under normal ambient conditions. Where the chain is exposed or encased but not submerged in oil, a heavier product such as an SAE 140 grade gear lubricant should be used.

Modern conveyor chain systems have been designed to increase the flexibility and ease of handling of packaged dairy products and empty milk cases. In one modern installation, a conveyor system originates in the bottling room, travels through a cold storage room and then to a truck loading area. The filled cases can be removed for storage or they can travel directly to awaiting trucks. A return system is used so that empty cases may be unloaded from the retail trucks and transported to the empty bottle and case area. In some instances, automatic case-stacking machines are used to stack empty cases six high or filled cases five high to provide greater handling capacity. The conveyor chain travels at about 22 feet per minute. Figure 23 illustrates a conveyor system bringing empty metal cases to paper container filling machines.

Depending upon their location, speed, load, clearances and extent of bending, conveyor systems may be lubricated by grease or oil, and in some instances by hand application of a cake of water-soluble soap.

Refrigeration Equipment

During the many steps involved in handling milk in the dairy industry, temperature control is a very important factor. Refrigerating compressors of the horizontal or vertical, reciprocating single or double acting type or centrifugal compressors are used. A cross section view of a multi-cylinder ammonia compressor is shown in Figure 24. Pressure lubrication is used to a large extent since it assures that an adequate supply of oil is delivered to the cylinder walls and compressor bearings.

Lubrication of refrigerating machinery is unique in that the action and effects of the compressor oil upon parts not requiring lubrication must be considered along with the lubricating ability. Oil congealed in any part of the refrigerating system will tend to reduce its efficiency if the oil becomes so sluggish under the low temperatures involved as to coat the interior of the expansion coils; this will affect the heat transfer rate. An oil for refrigerating machinery lubrication therefore must remain fluid at the lowest temperature to which it may be subjected during the operation.

Where the temperature in the refrigerating coil is below 5°F a low pour test oil having a viscosity of about 150 seconds Saybolt at 100°F will be necessary. Above this temperature, an oil of somewhat higher viscosity, i.e. 200 to 500 seconds Saybolt depending upon the recommendation of the compressor builder, can be used. A highly refined distilled mineral oil should be used to assure that these requirements are met.

Speed Reduction Units

A wide variety of speed reduction units employing helical, spur and worm gearing are used in dairy service. Since loads are moderate and the units are usually inclosed like that illustrated in Figure 22, the best lubrication is provided by a rust and oxidation inhibited premium type turbine and hydraulic oil.

Simplified Lubrication Plan

The use of simplified lubrication plans has become increasingly popular in plants having a multitude of lubrication requirements. In many instances, much confusion, uncertainty of lubrication and unnecessary expense has resulted from the common fault of stocking and trying to use a greater variety of lubricants than is actually necessary for the machines. The basic principle of the simplified lubrication plan is to select a minimum number of lubricant types of adequate quality so as to provide satisfactory lubrication for the mechanisms involved. Such a selection can be made by a trained lubrication engineer after making a careful survey of the equipment being used. In some cases the lubricant selected for a given mechanism may be of a "higher quality" than actually required. However the small additional expense is more than compensated for by the overall advantages of the plan wherein the number of lubricants held in inventory is kept to a minimum.

Table I presents a summary of the basic types of lubricants that can be used to handle the majority of mechanisms found in dairy industry machinery. While specific requirements may vary slightly, this table furnishes a general guide for lubricant selection.

SUMMARY

Production of fluid milk and milk by-products has shown an upward trend in the past twenty years. Increased production has been possible because of the many advancements made in techniques and equipment that are necessary for the processes involved. Milk handling equipment includes a variety of pumps, motors, conveyor systems and specially designed machines and mechanisms. The correct choice of lubricant for each of the many types of equipment plays an important role in obtaining optimum performance.

Printed in U. S. A. by
Salley & Collins, Inc.
305 East 45th Street
New York 17, N. Y.

TEXACO

Simplified Lubrication Plan for Dairy Industry Equipment

Mechanism	Lubricant
Air compressors	
reciprocating	Texaco Regal Oil C R&O
rotary	Texaco Regal Oil G R&O
Chain drives	
exposed	Texaco Regal Oil K R&O
inclosed	Texaco Regal Oil C R&O
Cream separators and clarifiers	Texaco Regal Oil C R&O or Texaco Regal Oil PE R&O
Hydraulic systems	Texaco Regal Oil A R&O
Homogenizers	Texaco Regal Oil G R&O
Speed reduction units	Texaco Regal Oil G R&O or Texaco Regal Oil K R&O
Vacuum pumps	Texaco Regal Oil C R&O
Conveyor bearings	
oil lubricated	Texaco Regal Oil C R&O
grease lubricated	Texaco Regal Starfak Premium 2
Electric motor bearings	
oil lubricated	Texaco Regal Oil C R&O
grease lubricated	Texaco Regal Starfak Premium 2
Pressure pump bearings and drive gears	
oil lubricated	Texaco Regal Oil C R&O
grease lubricated	Texaco Regal Starfak Premium 2
Grease fittings	Texaco Regal Starfak Premium 2
Ammonia refrigeration compressors	Texaco Capella Oil B Waxfree or Texaco Capella Oil C Waxfree or Texaco Capella Oil D Waxfree

Lubricant	Description
Texaco Regal Oil R&O	Premium grade rust and oxidation inhibited turbine and hydraulic oil.
Texaco Regal Starfak Premium	Premium oxidation-resistant rust-inhibiting ball, roller and plain bearing grease; useable temperature range −40°F to +250°F; lithium soap; oil viscosity 225 SUS at 100°F.
Texaco Capella Oil Waxfree	Highly refined, dewaxed, low cloud point refrigeration oil; viscosity grade as recommended by compressor manufacturer.

HOME-MADE CATTLE FEEDER SAVES TIME AND MONEY

Roy Spencer (right), who farms more than 400 acres near Downs, Ill., built the automatic auger feeder shown, at a cost of about $70. Feed is dumped in at the end and is distributed in the feeding troughs by the auger. An old car transmission gives the auger variable speeds, including reverse. Mr. Spencer is able to feed 40 head of cattle at a time and save labor—which means *money*. Texaco Representative Frank Dwyer is shown at left.

Roy lubricates his farm machinery with Texaco Marfak because it sticks to bearings better and longer. It forms a collar around open bearings, sealing out grit and dirt. Marfak won't jar off, wash off, melt down and drip out, dry out or cake up. It cushions bearings, adding life to farm machinery.

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